Fermenting different sugars in the wash.

The type of sugar used in the wash can result in a different flavour of the alcohol.

To change the alcohol profile and to get away from the sweetness you are best to change the composition of the raw material you are using for your wort. Using a % of dextose in the mix to replace a certain % of sugar will give you a fuller and rounder profile. At the end of the day it may all be alcohol but there are also slight nuances which are discernable to some peoples taste and more pronounced for others.

Introduction

Sugar molecules are formed from carbon, hydrogen, and oxygen by the process known as photosynthesis. Yeasts convert sugar molecules into alcohol and carbon dioxide (CO2) by means of a simple enzymatic action. There are many forms of sugar and the name the whole family is known under is saccharide.

Under certain conditions sugar molecules have an attraction for one another and 2 small molecules combine and form a bigger molecule. Sometimes these molecules combine and then sometimes combine again etc creating complex saccharide molecules or chains.

Small simple sugars are called monosaccharides,
* when 2 simple sugars combine they are called disaccharides, and
* when 3 or more combine they are called polysaccharides.

Large polysaccharide molecules consist of thousands of small monosaccharide molecules; pectin, gums, and cellulose are examples of these.

Monosaccharides

Monosaccharides are simple sugars and there are many different kinds with each sugar molecule containing 3, 4, 5, or 6 carbon atoms with each being named after these number of carbon atoms eg. pentose = 5, hexose = 6. The two main sugars we are concerned with namely glucose and fructose are hexose monosaccharides. Glucose is the sugar that provides the sugar for the human body. Fructose as well as being a component of sucrose is found in many different kinds of fruit and is the principle one in honey. Fructose is also sometimes known as levulose.

Glucose is the main common simple sugar and is a part of many different disaccharides and polysaccharides eg. corn starch (most common source). Disaccharides are composed of 2 simple sugars combined together which can either be similar or dissimilar sugars eg. Maltose = 2 glucose molecules (dimer or double molecule of glucose), sugar or sucrose = 1 glucose + 1 fructose molecule. Normally disaccharide sugars must be hydrolyzed and split into their simple sugar components before they can be fermented. In the case of sucrose (sugar) they are split into equal numbers of glucose and fructose molecules. Glucose has a Relative Sweetness level of 70 while fructose has double that level at 140. By switching a certain amount of glucose for sucrose it can be seen that it is relatively easy to adjust the Relative Sweetness level before one starts fermentation. Just try switching a certain amount of the glucose for the sugar say 20 to 25% initially (probably kg for kg) and go from there. You should end up with a less sweet alcohol.

Disaccharides
Disaccharides are produced commercially by the incomplete hydrolysis of larger more complex polysaccharides ie. the hydrolysis process is halted prematurely rather than being taken to the final stage of being further split into glucose and the other components sugar/s. It can also be produced by combining 2 monosaccharide sugars by means of a condensation reaction to form disaccharide sugars. Microorganisms such as yeast produce enzymes that hydrolyze sucrose.

Lactose is another disaccharide (milk sugar) and is only found in milk from mammals. It is made up of 1 glucose sugar and 1 galactose sugar molecule. In the case of NZ and Australia it is the major source of commercially available spirits. It is easily hydrolyzed and has practically no sweet taste having a Relative Sweetness of 40. It is therefore very easy to combine with most spirit bases without changing the profile. To hydrolyse lactose you need the enzyme lactase which allows the feedstock to then be fermented by the common Saccharomyces cerevisiae yeasts. A principal source of lactase is the yeast Kluyveromyces fragilis which is more commonly used to ferment lactose directly to ethanol.

Polysaccharides
Polysaccharides are large complex molecules containing 3 or more monosaccharides (and in some cases number more than several thousand simple sugar molecules) which are used by living organisms to store energy. They also form part of cell structural fibres. Starch consists of many glucose monosaccharides hooked together in both linear and branched forms. Pectin, gums, and cellulose are some of the other main polysaccharide molecules. Unfortunately cellulose is normally only fermented by xylose fermenting yeasts or bacteria so at least 30% of any plant materialis is generally always unfermentable. For polysaccharides to be fermentable they need to be split or broken down (hydrolyzed) again into simple sugars. This can be acheived by enzymes, acids, or heat.

Quite often the process is a joint one combining two or all three of these. The main enzymes used or part of alcohol fermentation are Alpha amylase, Beta amylase, Glucamylase (Amylogglucosidase), all of which are used to break down amylose (major component of starch) and amylopectrin (other major component of starch which is less easily hydrolyzed due to its large branched chains nature of construction). In addition other enzymes that are used are Beta glucanase, Lactase (milk sugar enzyme), Maltase, and Protease. Zymase is the complex of enzymes produced by yeasts which are responsibler for the fermantation of sugars to ethanol.

Acids that are involved or used in fermentation are Tartaric, Malic (wine), Succinic, Lactic, Citric, Proprionic, Sulpheric, and Hydrochloric.

Relative Sweetness
Chelsea Refinery (NZ Sugar Co. Ltd. quotes the following Relative Sweetness of the following:

Sucrose	100
Glucose	70
Fructose	140
Invert Sugar	110
Lactose	40
Maltose	50

Hence by switching some dextrose for sucrose the final product will taste less sweet. A lot of brewers use from 20 to 25% dextrose and some even more. The % used is kept dowm somewhat because of the slightly higher price. Obviously the difference in finished alcohol is marginal and nothing like the Relative Sweetness figures quoted.

Note that whisky is largely made from barley (simple sugars) and neutral grain alcohol which is mostly made from corn or maize (corn sugar = glucose). Bourbon likewise is is almost solely corn or maize. Rum in comparison is almost solely made from sugar (sucrose). Compare the 2 and you will quickly get the idea. The difference is minimal rather than profound. After all alcohol is alcohol. It is just that it gives the finished alcohol a fuller and rounder profile.

Note also that the majority alcohol made is mostly made from lactose which has a sweetness of 40.

Attenuation

While there is not much published in regard to problems like this with regards to spirits alcohol there is a lot of published data with regard to beer fermentation and the resultant products produced which is almost identical. It comes under what is called attenuation and is the main reason certain specific yeasts are used to produce specific beers.

Attenuation refers to the % of sugar converted to alcohol and is normally between 67 - 77% (Higher with actual sugar). This is determined by the composition of the wort (in your case actual sugars used) and the yeast strain used. In simple terms each yeast strain ferments different sugars to varying degrees resulting in higher or lower final gravities which affect the residual sweetness and body.

By playing around a bit with both the sugar/s composition and the yeast/s used it should be relatively easy to change this character aspect. By being precise and keeping good records you should after a while get to the stage where the results are repeatable and the taste more along the lines you like and desire.

How do the different sugars contribute to the sweetness in the distillate?

Because hardly any distillation is absolutely pure (ie. above 192.6 proof or 96.3% with the azoetrope) there is a certain amount of the congeners or contaminants carried with it in the form of bonded molecules as virtually no fermentation goes to the absolute limit where everything is converted.

Alcohol therefore tends to show its origins. The simpler the sugars (ie. monosaccharides c/f dissacharides) the greater the conversion. Also the greater the purification (ie. alcohol %) the less this is noticeable.

This is why rum fermented almost solely from molasses or sugar syrup distilled at a lot lower % apart from the actual congeners is so distinctive and also why vodka tends to be vodka regardless of source. At the very high levels it is only those of us with very distinctive palates who can discern. The more complex and longer the makeup chain of the starting sugars the more difficult it is to convert. This is why we end up with what are called hung fermentations. Sometimes some of the more complex sugars (dextrins) are not totally converted.